Space Weather Technical Forecast

Issued on Wednesday, 25 May 2022 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1-R2 Radio Blackouts. Minor geomagnetic storms possible on 26th or 27th.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the last 24 hours with only C-class flare activity observed, mainly from AR3017 (Eai/Beta-gamma) and AR3014 (Ekc/Beta-gamma-delta) both in the northwest quadrant. A C5.1 flare was observed at 24/2217 UTC from the new, unnumbered region (Dao/Beta) that has rotated over the eastern limb in the past 24-hours. The remaining six regions are all small and currently benign. No Earth-directed CMEs have been observed on available imagery.

Solar Wind / Geomagnetic Activity: The solar wind at L1 has followed a slow, but steady decline through the last 24 hours from around 420km/s to around 380km/s as the high speed stream from Coronal Hole 82 continues to ease. Density has been mainly below average. Total magnetic field strength was weak, with the north-south component, Bz, only varying weakly. The Phi angle has mainly been in the positive (away from the sun) sector. Total geomagnetic activity was Quiet throughout.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at background levels through the last 24 hours. The high energy electron flux (greater than 2 MeV) has mainly been at moderate levels, with a peak value of 968pfu at 24/1710UTC. Corresponding electron fluence remained well below the Active threshold (1e8 integrated pfu) with a rising then level trend to reach 4.80e7 integrated pfu at 25/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low, but with a chance of Moderate activity and a very slight chance of High activity. This is due to three moderately large and complex regions; two in the northwestern quadrant and one near the eastern limb. Additionally there is the potential for further new complex regions to rotate across the eastern limb in the coming days.

Solar Wind / Geomagnetic Activity: No CMEs are currently forecast at Earth during the period. Solar winds are expected to be at ambient levels through 25th and 26th May. Two coronal hole high speed stream connections late on the 26th and more likely early on 27th May could elevate winds to between 500-550km/s (elevated). Geomagnetic activity is expected to be Quiet on Day 1 and much of Day 2. There is an increasing risk of Active intervals on Day 2, but more likely on early Day 3 (27th May) with a slight chance of G1/Minor Storms. Geomagnetic activity should return to Quiet or Unsettled levels by Day 4 (28th May).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at background levels during this period, with a slight chance of reaching S1/Minor Storm levels. High energy electron flux (greater than 2MeV) is expected to be at generally moderate levels through Day 1 and Day 2 (25th and 26th May), perhaps falling to background levels on Day 3 (27th May) due to geomagnetic enhancements. Electron flux should rise on Day 4 (28th May) possibly reaching High levels. Electron fluence is forecast to follow a declining

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trend for the next 2-3 days, remaining below the Active threshold, then with a slight rise possible on Day 4.

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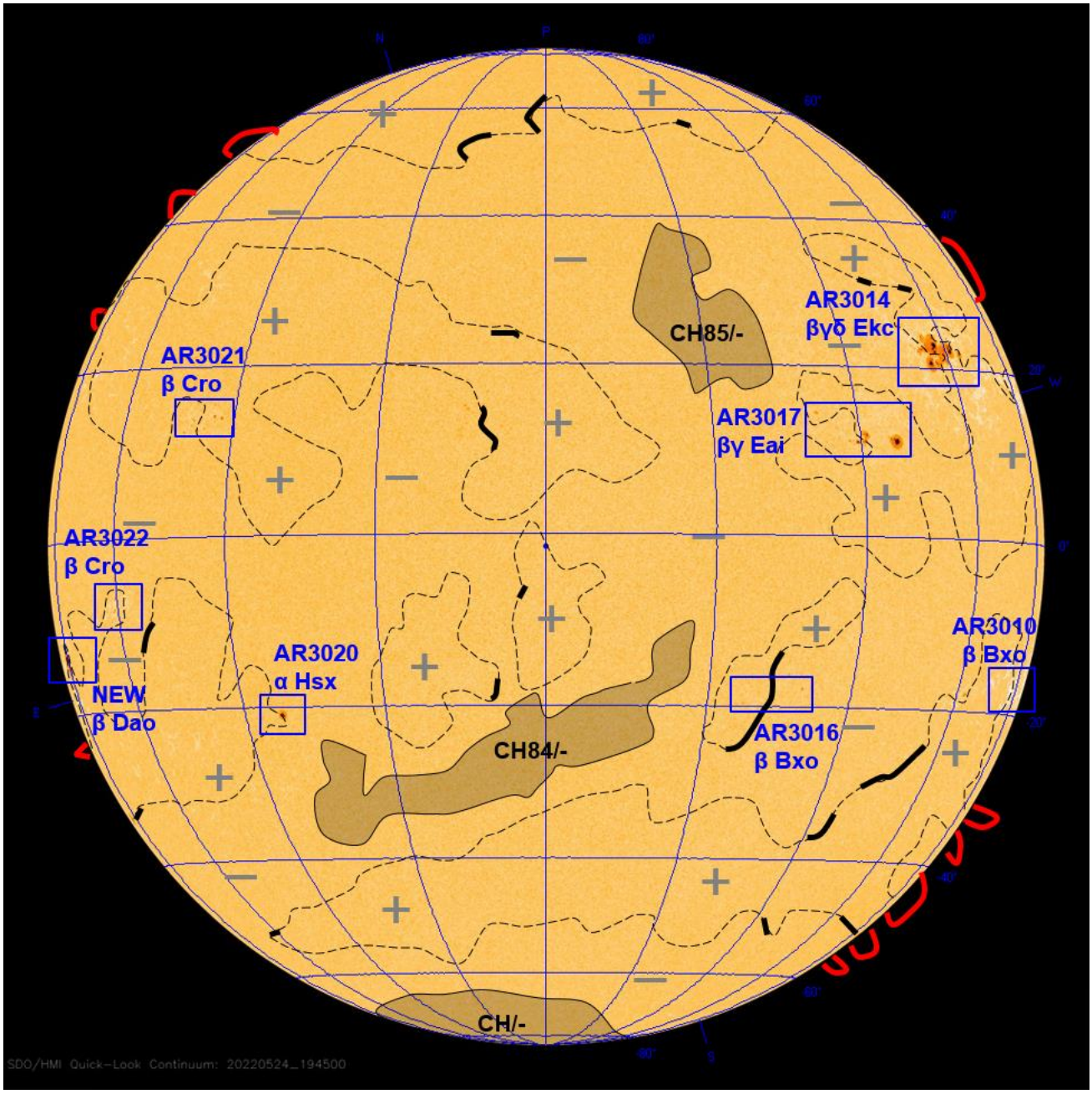
Figure 1. Solar Analysis Valid 24/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no earth-directed CMEs currently in the forecast.

Solar wind speeds are expected to remain at background levels on Day 1 and 2 (25th and 26th May). Late on the 26th, or early 27th (Day 3) Earth may to connect to high speed stream from Coronal Hole 85, located in the northern hemisphere mid-latitudes. Given that it is a new feature on this rotation and also that Earth is currently positioned below the sun's equatorial plane, there is low confidence of a relatively weak high speed stream arriving at earth from this feature. A connection to the high speed stream from Coronal Hole 84 carries much higher confidence and is expected at Earth either later on Day 2 or during Day 3. This is a persistent feature which produced winds of 500-550km/s (elevated) on the last rotation, with similar speeds forecast on this occasion. This is based both on the visual strength of the feature and recent observations from STEREO A.

Geomagnetic activity is expected to be Quiet on Day 1 and much of Day 2. There is an increasing risk of Active intervals due to any connection with Coronal Hole 84 or 85 late on Day 2, but more likely on early Day 3 (27th May) with a slight chance of G1/Minor Storms. Geomagnetic activity should return to Quiet or Unsettled levels by Day 4 (28th May).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

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Radio Blackouts - X-Ray Flares:

Solar Activity is currently Low with the largest flare observed a C5.1 at 24/2217 UTC from the as yet unnumbered region (Dao/Beta) located around S14 E81. This sunspot region is significantly foreshortened in available coronagraph imagery, so further analysis is required once it rotates into clearer view, to confirm the magnetic configuration of the group.

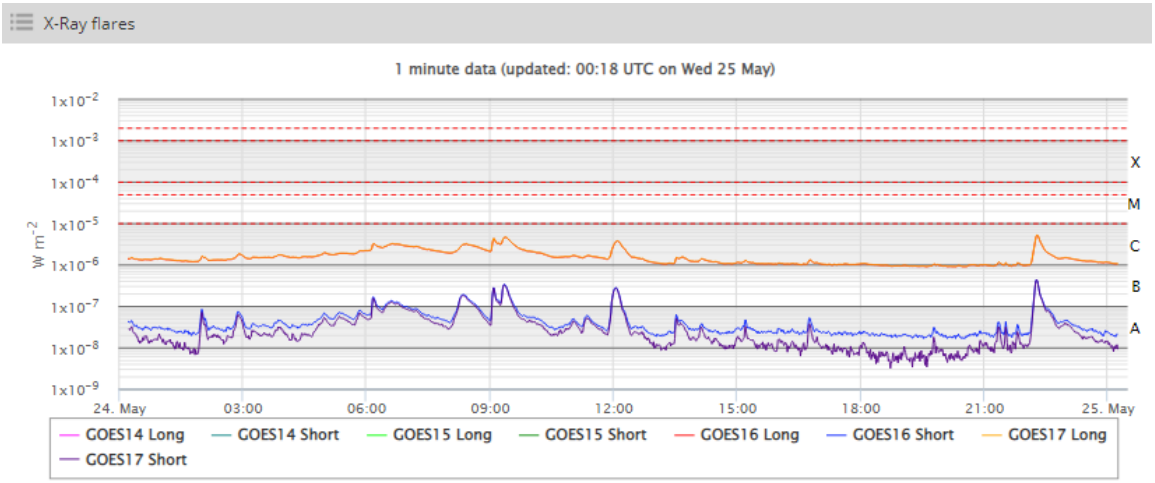
Historically, AR3014 (Ekc/Beta-Gamma-Delta) and AR3017 (Eai/Beta-Gamma) in the northwest quadrant have been the most significant regions on the visible disc, though both have not significantly flared in the past 24-hours, with only low-mid level C-class flare activity. AR3014 is a moderately large sunspot with a delta spot and beta-gamma-delta configuration, though appears to be simplifying magnetically in recent hours towards a beta-delta configuration. AR3017 has simplified in recent hours in respect of the intermediate spots between leader and trailer fading away. However, tentatively there may also be a delta spot forming on the rearward portion of this group, so will continue to be closely monitored in its evolution and potential for significant flaring.

There are five further regions visible, with all of these simple unipolar or bipolar regions presenting very low flare risks. Bright flux on STEREO A EUVI imagery suggests that further significant sunspot regions could rotate across the eastern limb through the next four days.

Solar activity is expected to be mainly Low, but with a chance of Moderate activity and a very slight chance of High activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 2: GOES-16/17 X-ray flux



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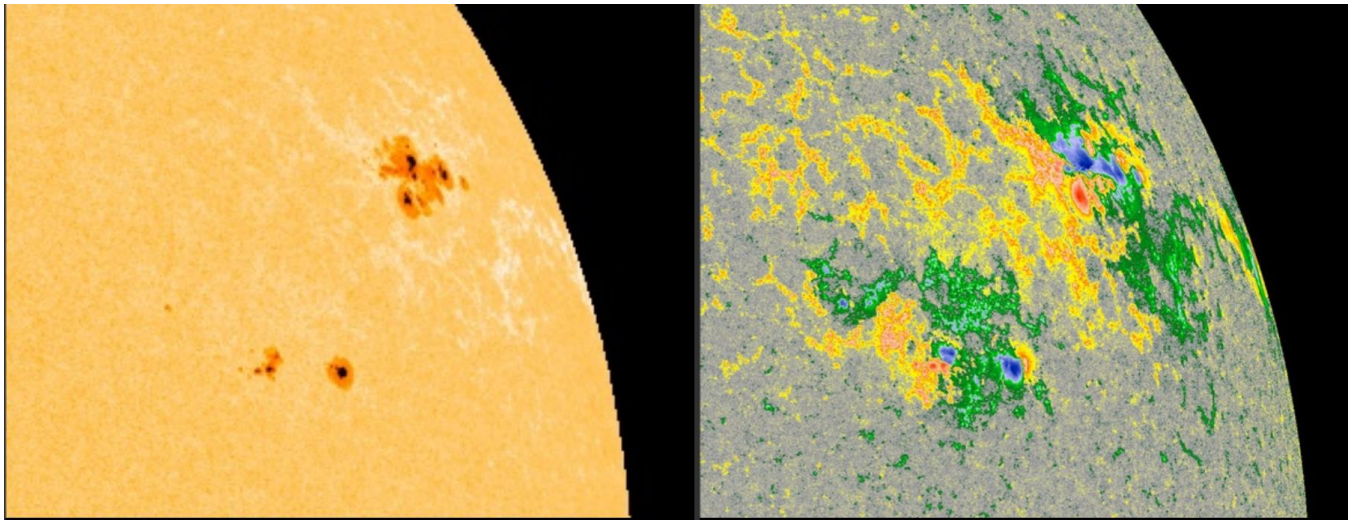
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is most likely to remain so through the period.

There is a slightly increased risk of solar radiation storms through the next four days as regions AR3014 and AR3017 rotate towards the western limb, with this being the prime region for Earth-directed storms.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 3: SDO HMI-Intensitygram and Magnetogram of AR3014 (top-right) and AR3017 (lower-left).



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has declined during the last 24 hours, with the latest peak lower than for the previous day. This trend is expected to continue for the next two days, with a more significant drop to background then likely on Day 2 or 3 (26th or 27th May) due to geomagnetic effects of coronal hole high speed stream connection(s). A rising trend is possible from Day 4 (28th May), but this is dependent on the extent to which the high speed stream(s) distort the radiation belts.

Electron fluence is now likely to have peaked for the period, with a declining trend through Day 3. A slightly rising trend is possible at the end of the period, but the Active (1e8 integrated pfu) threshold is unlikely to be breached.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	5	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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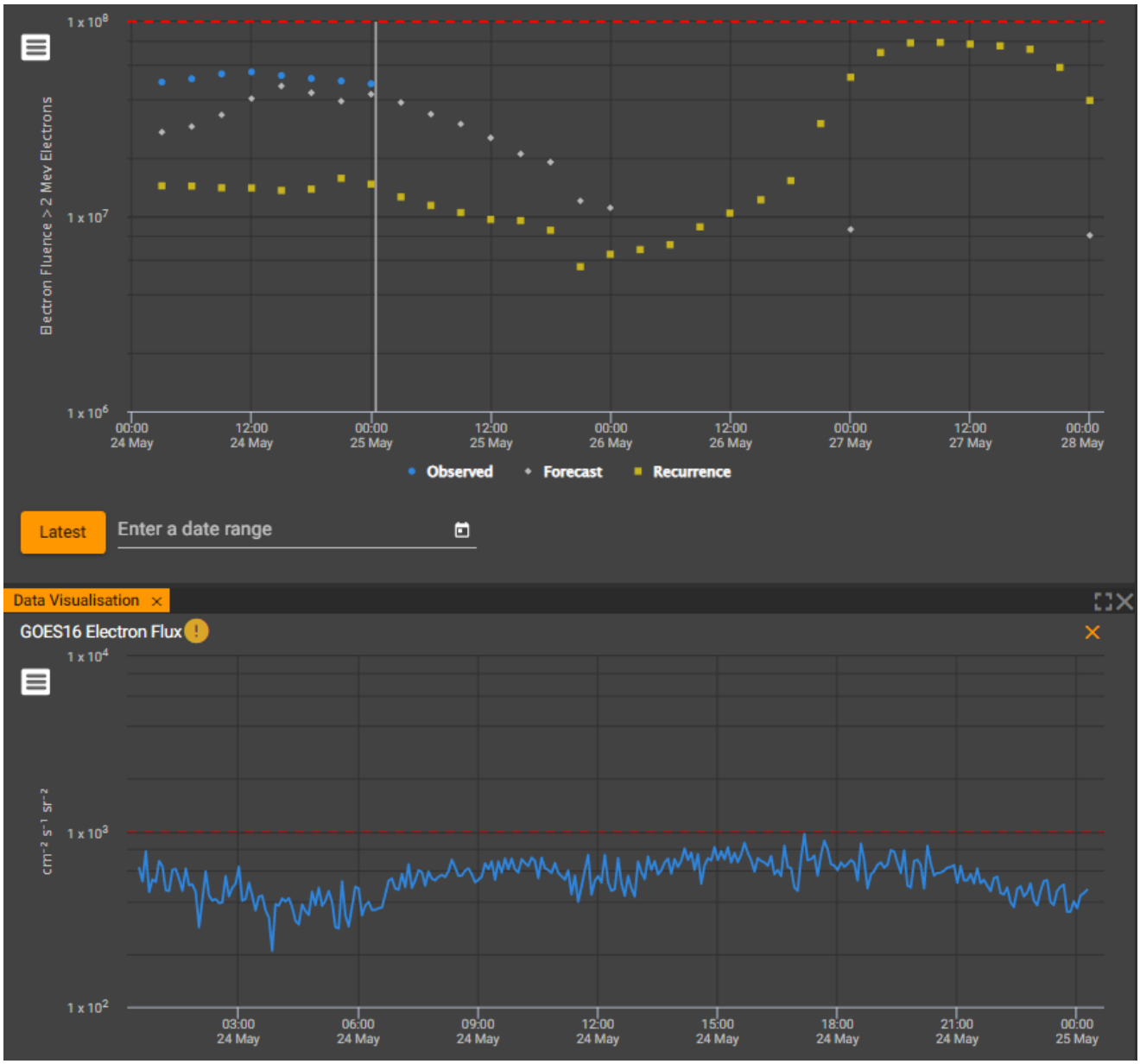
Figure 4: GOES-16 >2MeV Electron Flux and fluence with REFM



NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph, which superimposes observations from the last solar rotation onto the current solar rotation (each plot is the observation from T-minus 28 days). Recurrence is used as a guide to what can be expected in the coming days assuming no difference in solar features, and has low accuracy in certain situations but good accuracy in others (such as recurring coronal holes). The other change is the cadence of REFM forecast fluence data has been reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.

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